

39. Experimental Evidence that Commensalism may be beneficial to Crustacea. By EDWARD B. POULTON, D.Sc., F.R.S., F.Z.S., Hope Professor of Zoology and Fellow of Jesus College in the University of Oxford.

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The special associations of Crustacea with organisms believed to be disliked by their enemies—with Sponges, Ascidians, and Sea-anemones—has probably been derived from a more generalized use of animal and vegetable growths for the purpose of concealment. The following experiments proved that two conspicuously coloured forms associated with Hermit-crabs were intensely distasteful to fishes, and that one of the crabs, when deprived of its associate, was greedily devoured. The experiments were carried out, with the help and advice of Prof. W. Garstang, in the Marine Biological Laboratory at Plymouth in the summer of 1890. The results have often been described, but never published.

(1) *Pagurus bernhardus* and its Sea-anemone, *Sagartia parasitica*.—These Crustacea were commonly dredged up at Plymouth, and large specimens bore on the shells—generally whelks—from two as to as many as six of these large brightly coloured actinians. Prof. Garstang had already obtained much indirect evidence of the value of the association, for he had often found the young Hermit-crabs, too small to carry a Sea-anemone, in the stomach of gurnards and other fishes. They had been swallowed entire, their borrowed shells and all. He had, however, never found in the fishes any of the larger crabs living in shells suited for carrying *Sagartia*\*.

I first tested the nematocysts of the *Sagartia* by touching it with the tip of my tongue, and at once experienced a sharp smart which endured for many hours. Pieces of about the size and shape of the bits of meat on which the fish in one of the tanks were accustomed to be fed were then cut from a Sea-anemone and thrown into the tank. Misled by this, a few fishes seized pieces of the *Sagartia*; but no sooner had one been received into the mouth, than it was shot out again with much force, and the fish shook its head violently from side to side, apparently feeling the same smart which I had experienced myself. After these first trials not one of the fish would touch the pieces, and it was obvious that the great majority saved themselves by yielding to the stimulus provided by the behaviour of the others.

(2) *Pagurus cuanensis* and the Sponge, *Suberites domuncula*.—This small Hermit-crab, also common at Plymouth, inhabits a cavity in the sponge, the tip of its tail being fixed in a small

\* These facts are recorded in "Colours of Animals," Internat. Sci. Ser., Lond. 1890, p. 203.

gastropod shell, while the rest of its body lies in a spiral canal continuous with that of the shell and gradually prolonged from it with the growth of the two associated organisms. The small shell was evidently inhabited by the young crab when the association began, but had become deeply buried in the sponge at the time when the experiments were made. The sponge was of the usual orange-red colour, although they are sometimes dark and comparatively inconspicuous. In size and shape it resembled a smallish potato.

When disturbed or frightened in any way, the crab darted back into its sponge exactly as other Hermits dash into their shells.

In order to obtain pictures of this species and *P. bernhardus* under as natural conditions as possible, the objects dredged up with each species were arranged in a dish, which was lowered into an aquarium so that its edge was in contact with the glass front and its contents well lighted from above. The crabs were secured in the most convenient position by tying to a stone in the dish. Although the string was wound so as not to touch *P. cuaneusis*, and was, in fact, separated from its body by a considerable thickness of sponge, the crab quite understood the situation, and spent the whole time the artist was at work in trying to wear through the string with its two large claws. Thus occupied and stretching out of its canal, it was an admirable sitter.

Prof. Garstang had already recorded that sponges as a group are intensely disliked by fishes\*, but I was anxious to test this special example and compare its palatability with that of the crab. Pieces like those of the *Sagartia* were therefore thrown into the aquarium, but were recognized as unpalatable even more quickly than the others, and seized by fewer fishes. When taken they were instantly rejected. The *Pagurus* was then offered deprived of his sponge; there was a wild struggle, and the fortunate captor swallowed him in a moment.

It was evident that both these Hermit-crabs are associated with organisms possessing qualities rendering them unpleasant to fishes—qualities advertised by conspicuous warning colours. One of the crabs was shown on this occasion to be very palatable to fishes, and the other previously by Prof. Garstang, to be much sought after by them. Although the experiments described were very few, the results were so definite and clear that there can be little doubt about the meaning of the association in these and other similar examples of commensalism in Crustacea.

The beautiful illustrations, projected upon the screen, were painted in 1890 by my friend the late Mr. H. M. J. Underhill, of Oxford, who has reproduced the appearance of the living animals in their natural surroundings with wonderful skill.

\* "Colours of Animals," l. c.